

Product description

This chapter describes Fiber Remote Multi-IPE Interface, its architecture, and its hardware options.

It also describes how to plan and engineer a fiber-optic link that connects the local and the remote Fiber Remote Multi-IPE Interface units

System overview

Meridian 1 is a Private Branch Exchange (PBX) that links local subscribers to private and public networks and provides a large number of subscriber functions and features.

In addition to supporting local subscribers, Meridian 1 can be configured using Remote IPE modules as a distributed system that supports remote subscribers. The Remote IPE modules are connected to Meridian 1 at long distances using fiber-optic links at transmission speed at 45 Mbps.

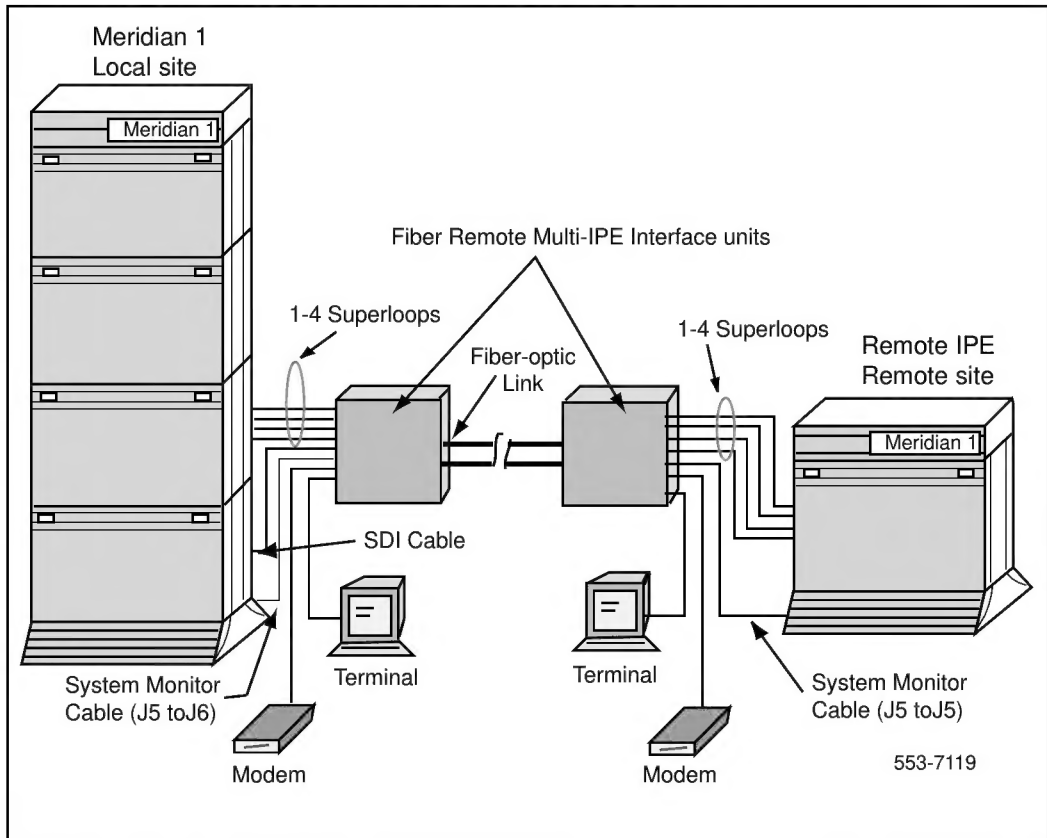
The Fiber Remote Multi-IPE Interface is compatible with Meridian 1 system options 21E, 51C, 61C, 71, and 81C. It is also compatible with NT and XT systems that have been upgraded to support IPE cards. The Fiber Remote Multi-IPE Interface is compatible with X11 release 19 and later software.

Subscriber connections at local Meridian 1 IPE modules are the same as the Remote IPE modules. The subscriber functions and features at the Meridian 1 are also the same as for the Remote IPE site.

This document focuses on the Fiber Remote Multi-IPE Interface equipment specifically designed to provide fiber-optic links between the network functions in Meridian 1 and the peripheral controller functions in the Remote IPE. It also describes how and where to install and how to configure the Superloop Network and Peripheral Controller cards that support the Remote IPE application.

Figure 1 illustrates the Meridian 1 system and the application of the Fiber Remote Multi-IPE Interface and the fiber-optic link to connect the Remote IPE site with the Meridian 1 local site.

Figure 1
Meridian 1 to Remote IPE connection over the fiber-optic link



System description

The Fiber Remote Multi-IPE Interface links Meridian 1 with one or more Remote IPE sites to provide Meridian 1 functionality to these Remote IPE sites. Each Remote IPE shares Meridian 1 common and network equipment to provide the same functions and features to remote subscribers that are available to local Meridian 1 subscribers.

To explain the implementation of Fiber Remote Multi-IPE Interface functions, we will describe:

- Fiber Remote Multi-IPE Interface physical architecture
- Fiber Remote Multi-IPE Interface functional architecture

Fiber Remote Multi-IPE Interface physical architecture

To configure a Meridian 1 system with one or more Remote IPEs, you can install one or more IPE modules at a remote site and connect them to an existing Meridian 1 system using a pair of Fiber Remote Multi-IPE Interface units; one at the local Meridian 1 site and another at the Remote IPE site. These two Fiber Remote Multi-IPE Interface units are connected by a fiber-optic link at a distance of up to 15 miles over a single-mode optical fiber.

Fiber Remote Multi-IPE Interface options

The Fiber Remote Multi-IPE Interface is available in four different options. These are:

- A0634488 Single-mode fiber supporting four superloop
- A0634489 Single-mode fiber supporting two superloops
- A0634490 Multi-mode fiber supporting four superloops
- A0634491 Multi-mode fiber supporting two superloops

These Fiber Remote Multi-IPE Interface options allow you to configure the superloop connections at the remote site the same way they are configured for the IPE modules at the local site. A Superloop Network card can be connected to support one to eight segments in an IPE module the same way it supports them in a local IPE module in the Meridian 1 column. Actually, a Superloop Network card can support a co-located IPE module with, for example, the superloop extended from the faceplate connector J1 and the Remote IPE site with the superloop extended from the faceplate connector J2 at the same time.

Table 1 shows how the superloop connections can be configured and which option Fiber Remote Multi-IPE Interface should be used to connect Meridian 1 to the Remote IPE site. The superloop configuration you select will depend on the traffic requirements at the remote site. If non-blocking is required, three or four superloops for each fully equipped Remote IPE module may be required. If call blocking is not an issue, a single superloop may be used for this application.

Note: Up to four superloop links are supported by a pair of Fiber Remote Multi-IPE Interface units; one unit at each end of the fiber-optic link.

From Table 1 you can conclude that:

- **One segment per superloop.** Requires transmission of four superloop links over the Fiber Remote Multi-IPE Interface and the fiber-optic link to a single Remote IPE module. Note that each Remote IPE module is divided into four segments. Call connections are not blocked.
- **Two segments per superloop.** Requires transmission of two superloop links over the Fiber Remote Multi-IPE Interface and the fiber-optic link to each Remote IPE module. Minimal to no call blocking.
- **Four segments per superloop.** Requires transmission of one superloop link over the Fiber Remote Multi-IPE Interface and the fiber-optic link to each Remote IPE module. Call blocking in high traffic conditions.
- **Eight segments per superloop.** Requires transmission of two superloop links over the Fiber Remote Multi-IPE Interface and the fiber-optic link to two Remote IPE modules. Call blocking in high traffic conditions.
- **One segment for one superloop and three segments for the second superloop.** Requires transmission of two superloops over the Fiber Remote Multi-IPE Interface and the fiber-optic link to a single Remote IPE module. No call blocking for one segment, blocking for the rest.
- **Two segments for one superloop and six segments for another two superloops.** Requires transmission of three superloops over the Fiber Remote Multi-IPE Interface and the fiber-optic link to two Remote IPE modules. Minimal blocking for first four segments in one IPE module and blocking for the last four segments in the second IPE module.

Note: Each segment example in Table 1 is configured over a pair of Remote Multi-IPE Interface units as shown in Figure 1.

Table 1 lists various superloop-to-peripheral controller connection combinations. It shows the connections from the Superloop Network card faceplate connectors J1 and J2 to the Remote IPE backplane connectors SL0 through SL3. Internal cables connect J1 and J2 to the network I/O panel at the Meridian 1 local site and similarly, internal cables connect SL0-SL3 backplane connectors to the Remote IPE I/O panel. From these I/O panels, the external cables connect to the Fiber Remote Multi-IPE Interface units.

Table 1
Superloop connection configurations

Remote IPE Segments per Superloop (Max 4 segments per one IPE module)	Connecting from Meridian 1		Connecting to Remote IPE	
	Superloop Network Card	Faceplate Connector	Controller Card	Backplane Connector
One segment per superloop	NT8D04 #1	J2	NT8D01BC #1	SL0
	NT8D04 #2	J2	NT8D01BC #1	SL1
	NT8D04 #3	J2	NT8D01BC #1	SL2
	NT8D04 #4	J2	NT8D01BC #1	SL3
Two segments per superloop	NT8D04 #1	J2	NT8D01BC #1	SL0
	NT8D04 #2	J2	NT8D01BC #1	SL1
Four segments per superloop	NT8D04 #1	J2	NT8D01BC #1	SL0
Eight segments per super-loop	NT8D04 #1	J1	NT8D01BC #1	SL0
	NT8D04 #1	J2	NT8D01BC #2	SL0
One segment per one super-loop/three segments per other superloop	NT8D04 #1	J2	NT8D01BC #1	SL0
	NT8D04 #2	J2	NT8D01BC #1	SL1
Two segments per superloop and six segments per another superloop	NT8D04 #1	J2	NT8D01BC #1	SL0
	NT8D04 #2	J2	NT8D01BC #1	SL1
	NT8D04 #2	J1	NT8D01BC #2	SL0
Note: NT8D01BC Controller -4 replaces both NT8D01AC Controller-4 and NT8D01DC Controller-2 for new installations.				

Table 2 lists the equipment required to link the Meridian 1 network equipment to the Remote IPE peripheral equipment external to the Meridian 1 column and Remote IPE modules. All the equipment contained in the Meridian 1 column(s) as well as the equipment contained in Remote IPE modules is standard Meridian 1 equipment not specifically design to support the Fiber Remote Multi-IPE Interface and the fiber-optic link.

Table 2
Equipment required to link Meridian 1 to Remote IPE sites (Part 1 of 3)

Component	Description
A0634488 Fiber Remote Multi-IPE Interface Unit	Supports single-mode fiber-optic link for four superloops at connector positions SUPERLOOP-1 through SUPERLOOP-4 .
A0634489 Fiber Remote Multi-IPE Interface Unit	Supports single-mode fiber-optic link for two superloops at connector positions SUPERLOOP-1 and SUPERLOOP-2 .
A0634490 Fiber Remote Multi-IPE Interface Unit	Supports multi-mode fiber-optic link for four superloops at connector positions SUPERLOOP-1 through SUPERLOOP-4 .
A0634491 Fiber Remote Multi-IPE Interface Unit	Supports multi-mode fiber-optic link for two superloops at connector positions SUPERLOOP-1 and SUPERLOOP-2 .
A0634492 Fiber Remote Multi-IPE Interface Redundant Option	A daughterboard with fiber-optic connectors that is installed onto the motherboard to supports single-mode redundant fiber-optic link operation.
A0634493 Fiber Remote Multi-IPE Interface Redundant Option	A daughterboard with fiber-optic connectors that is installed onto the motherboard to supports multi-mode redundant fiber-optic link operation.
A0634494 Fiber Remote Multi-IPE Rack-Mounted Shelf	Supports up to six Fiber Remote Multi-IPE Interface units per shelf. Used where several units are co-located to save space. Usually at the Meridian 1 site (Optional).

Table 2
Equipment required to link Meridian 1 to Remote IPE sites (Part 2 of 3)

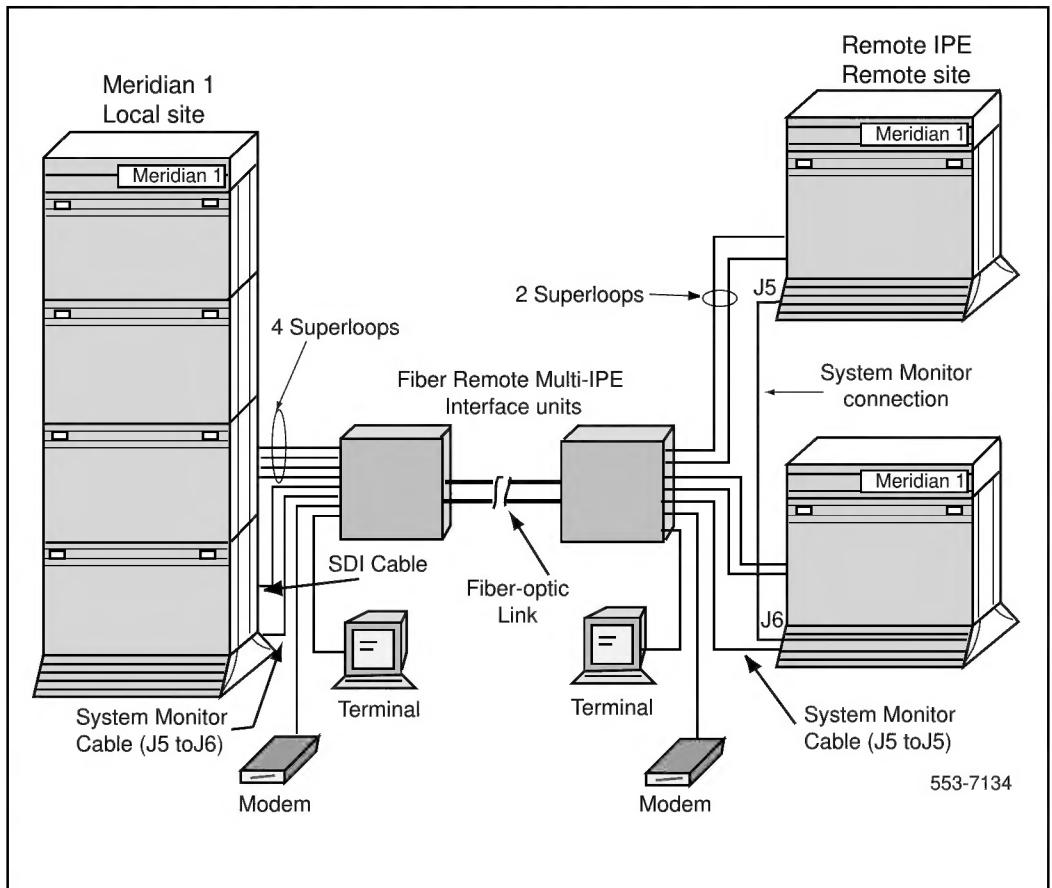
Component	Description
A0634495 Local Fiber Remote Multi-IPE Interface Cable	A 30 foot shielded cable connects the local Meridian 1 network I/O panel 24-pin Centronics connector to a Fiber Remote Multi-IPE Interface unit SUPERLOOP 37-pin D Shell connector.
A0634496 Remote Fiber Remote Multi-IPE Interface Cable	A 30-foot shielded cable connects the Remote IPE I/O panel 24-pin Centronics connector to a Fiber Remote Multi-IPE Interface unit SUPERLOOP 37-pin D Shell connector.
A0634497 Maintenance Interface Cable	A 2-foot DB-9 male to DB-9 female cable daisy-chains multiple co-located Fiber Remote Multi-IPE Interface units to share a common maintenance terminal. The male cable connector plugs into the SDI connector and the female cable connector plugs into the MAINT connector in the I/O panel at the rear of the Fiber Remote Multi-IPE Interface units.
A0634498 AC/DC Power Converter	A wall-mounted -48 Volt DC power converter with a 25-foot power cable is provided with each Fiber Remote Multi-IPE Interface unit.
A0654976 DC Power Cable	DC 25-foot power cable that is connected between a -48 V system power source and the Fiber Remote Multi-IPE Interface unit
A0654977 Attenuated Fiber Loopback Cable	Fiber-optic cable used to loopback at the ST fiber-optic connectors on the faceplate.
NT7R66AA SDI Cable Kit	This cable kit provides a 10-foot DB-9 male to DB-25 male cable and a DB-25F/DB-25F compact adapter. To connect the standard SDI card to the DB-9 female SDI connector of the Fiber Remote Multi-IPE Interface unit, use the cable but not the DB-25F/DB-25F adapter. To connect the SDI Paddleboard use the entire kit including the adapter. This kit is used together with the NT8D93AJ cable for the Paddleboard.

Table 2
Equipment required to link Meridian 1 to Remote IPE sites (Part 3 of 3)

Component	Description
NT7R66BA MMI Cable	This is a 32-foot DB-9 female to DB-25 male cable. Connect the MMI terminal to the DB-9 male MAINT port on the Fiber Remote Multi-IPE Interface unit.
NT8D46AL System Monitor daisy-chain cable (Similar cable may be purchased in any telephone equipment shop).	Connects RJ11 connectors XSM IN and XSM OUT daisy-chaining Fiber Remote Multi-IPE Interface units. This RJ11 phone cable has reverse leads: Black (2), Red (3), Green (4), Yellow(5) at one end of the cable and Yellow (2), Green (3), Red (4), Black (5) at the other end of the cable.
NT8D46AP System Monitor Serial Link Cable	Connects the 6-pin modular jack J5 on the Fiber Remote Multi-IPE I/O panel to the system monitor jack J6 in the pedestal.
NT8D88AD Network to I/O Panel Cable	A 6-foot cable that connects Superloop Network card J1 or J2 faceplate connectors to the network I/O panel.
NT8D92AD Controller to I/O Panel Cable	A 20-inch cable that connects one of the IPE backplane connectors SL0, SL1, SL2, or SL3 to the IPE I/O panel.
NT8D93AJ XSDI I/O to DTE or DCE Cable	Connects the Paddleboard DB-9 female connector to the an adapter cable that ultimately connects to the Fiber Remote Multi-IPE Interface unit.

Figure 2 illustrates Meridian 1 and Remote IPE equipment linked with fiber-optic cable over Fiber Remote Multi-IPE Interface units. Connections between Meridian 1 and Fiber Remote Multi-IPE Interface units depend on the number of superloops projected over the fiber-optic link to the Remote IPE modules at one or more remote sites. This figure shows two IPE Modules supported at the remote site. A maximum of four IPE Modules can be supported using a pair of Fiber Remote Multi-IPE Interface units.

Figure 2
Meridian 1 to Remote IPE connection over fiber-optic links



A maximum number of four superloops can be supported by a Fiber Remote Multi-IPE Interface unit. The transmission of these four superloops is handled by a single transmit and a single receive fiber-optic link in a non-redundant configuration. The primary ST-type fiber-optic connectors on the Fiber Remote Multi-IPE Interface faceplate are labeled XMIT A and RCV A.

In the redundant configuration, an additional set of fiber-optic transmit and receive connectors are added to the Fiber Remote Multi-IPE Interface motherboard by installing a daughterboard into the unit. These redundant ST-type fiber-optic connectors on the Fiber Remote Multi-IPE Interface faceplate are labeled XMIT B and RCV B.

Fiber Remote Multi-IPE Interface unit

The Fiber Remote Multi-IPE Interface unit is housed in a metal enclosure measuring 10.4x12x12 inches or (26.42x38.48x38.48 centimeters). This enclosure can be mounted on the wall or up to six of these enclosures can be installed into a 19-inch rack-mounted shelf. The shelf is normally used at the local site where there may be a number of Fiber Remote Multi-IPE Interface units supporting several Remote IPE sites.

The Fiber Remote Multi-IPE Interface unit has a faceplate that contains the ST-type fiber-optic connectors and the alarm and power LED indicators. At the rear of the unit an I/O panel contains connectors that connect the Fiber Remote Multi-IPE Interface unit to the Meridian 1 and the Remote IPE I/O panel connectors.

Figure 3 illustrates the front view of the Fiber Remote Multi-IPE Interface unit. It shows primary and redundant fiber-optic connectors to support a redundant fiber-optic link. It also shows the power and alarm indicator LEDs. The ejector tabs are used to eject the card. You can then access the motherboard to install the daughterboard or to set configuration switches.

Figure 3
Fiber Remote Multi-IPE Interface faceplate

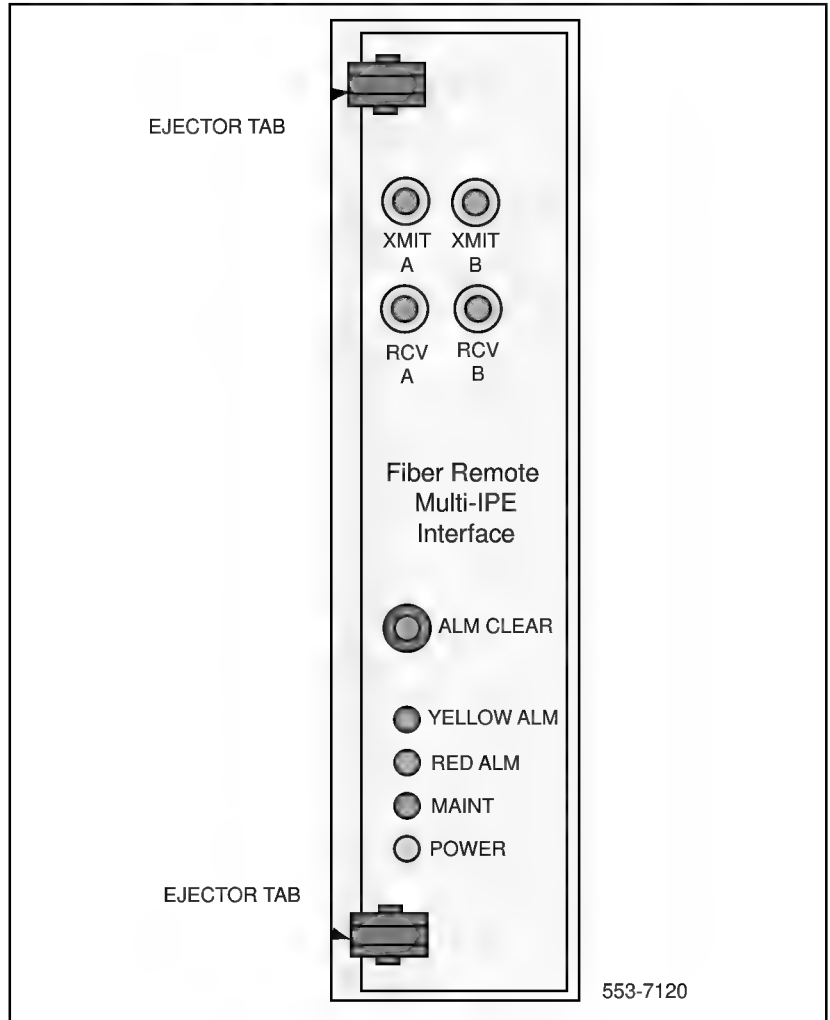
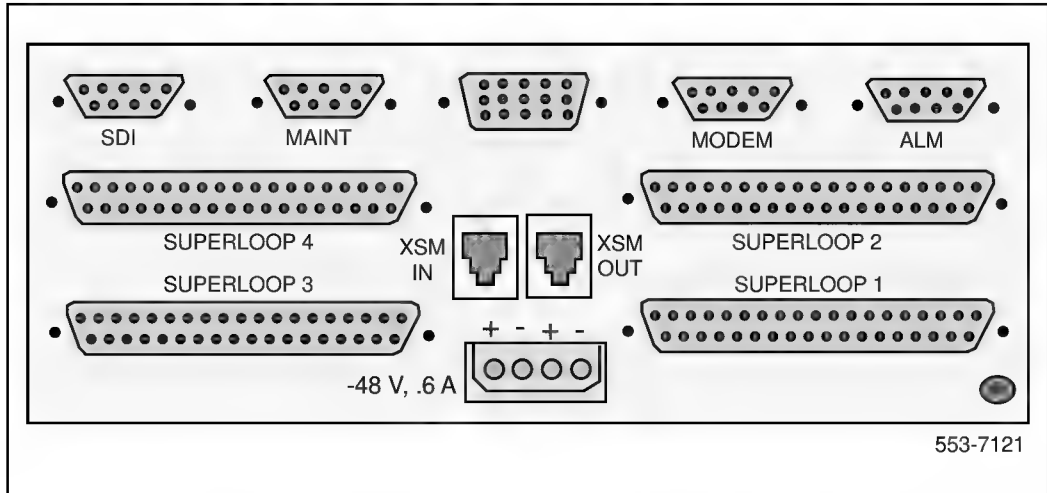


Figure 4 illustrates the rear view of the Fiber Remote Multi-IPE Interface unit. It shows the Fiber Remote Multi-IPE Interface unit I/O panel. The I/O panel contains connectors to connect the superloop cables, the system monitor cables, the SDI port, the MMI terminal, the modem, the external alarms, and the power.

Figure 4
Fiber Remote Multi-IPE Interface unit I/O panel-rear view



The Fiber Remote Multi-IPE Interface I/O panel connectors interface with the Meridian 1 and Remote IPE equipment over copper cables. The SDI and the MAINT connectors can also be used to daisy-chain multiple Fiber Remote Multi-IPE Interface units to provide common MMI terminal and SDI connections for all Fiber Remote Multi-IPE Interface units in the chain.

Table 3 lists all the Fiber Remote Multi-IPE Interface I/O panel connectors and describes their functions.

Table 3
Fiber Remote Multi-IPE Interface I/O panel connectors

Connector Name	Connector Type	Connector Function
SDI	DB-9 female	Connects to the SDI port in Meridian 1 or in a daisy-chain, to the MAINT connector of the preceding Fiber Remote Multi-IPE Interface unit.
MAINT	DB-9 male	Connects to the MMI terminal or in a daisy-chain to the SDI connector of the following Fiber Remote Multi-IPE Interface unit.
MODEM	DB-9 female	Connects to a modem for remote maintenance access to the Remote IPE. It can be connected at the local and at the remote site.
ALM	DB-9 male	Connects to external alarm devices.
XSM IN (J5)	6-pin modular jack	Connects to the XSM OUT (J6) jack on the upstream Fiber Remote Multi-IPE Interface unit, or Remote IPE system monitor.
XSM OUT (J6)	6-pin modular jack	Connects to the master system monitor J6 modular jack located in the Meridian 1 pedestal or the XSM IN (J5) jack or the downstream Fiber Remote Multi-IPE Interface unit.
SUPERLOOP-1 through SUPERLOOP-4	37-pin D Shell, male	Connect to the Meridian 1 network I/O panel or Remote IPE I/O panel 24-pin connectors.

Fiber Remote Multi-IPE functional architecture

The Fiber Remote Multi-IPE Interface converts a superloop format into a fiber-optic format and the fiber-optic format to the superloop format. Since this is a bidirectional link, the communication and signaling information flows from Meridian 1 to the Remote IPE site and from the Remote IPE site to Meridian 1.

To enhance the transmission reliability, the Fiber Remote Multi-IPE Interface can be equipped with a redundant fiber-optic link, which is automatically selected to carry traffic if the primary fiber-optic link fails.

The main functions of the Fiber Remote Multi-IPE Interface:

- Supports a fiber-optic link between the Meridian 1 and the Remote IPE over a pair of single-mode or multi-mode fibers.
- Monitors link performance and automatically switches from the primary to the redundant link if the primary link fails, if equipped.
- Provides system maintenance over the fiber-optic link in both directions.
- Performs diagnostic testing of the fiber-optic link and the superloops.
- Reports system monitor information from the Remote IPE sites to the Meridian 1.

Fiber-optic interface

The Fiber Remote Multi-IPE Interface links multiple Remote IPE sites with the Meridian 1 system over a single-mode or multi-mode optical fibers. With multi-mode fiber-optic link, the maximum distance between Meridian 1 and the Remote IPE site is approximately 6 miles. With a single-mode fiber-optic link, the maximum distance is approximately 15 miles. The actual distance depends on the quality of the fiber-optic cable and cable splices.

The Fiber Remote Multi-IPE Interface provides ST-type optical connectors, which are compatible with multi-mode fibers at 62.5um/125 um (micrometer) or with the single-mode fibers at 8.3 um/125 um.

A redundant fiber-optic link is optionally available on the Fiber Remote Multi-IPE Interface to provide greater transmission reliability between Meridian 1 and the Remote IPE sites. The Fiber Remote Multi-IPE Interface automatically transfers the communication to the redundant link when the primary link fails. When the primary link problem is corrected, it becomes the spare link and the transmission does not switch to it until the currently active link fails.

The Fiber Remote Multi-IPE Interface optical interface functions:

- Provides a single or a redundant dedicated optical link to connect the Remote IPE to Meridian 1.
- Monitors fiber-optic link integrity and transmission quality and provide automatic link switching from the failed primary link to the redundant link, if equipped.
- Provides local and remote loopback testing of the fiber-optic link by using a fiber-optic cable to loop the fiber-optic interface at either end of the fiber-optic link.

Superloop interface

The Fiber Remote Multi-IPE Interface is equipped with four superloop network connectors. These are 37-pin D Shell connectors that are used to directly connect the Fiber Remote Multi-IPE Interface to the Meridian 1 network I/O panel or the Remote IPE I/O panel 24-pin Centronics connectors. The Fiber Remote Multi-IPE Interface can accommodate from one to four superloops depending on the type selected. For types of Fiber Remote Multi-IPE Interface, refer to Table 2 “Equipment required to link Meridian 1 to Remote IPE sites” on page 8.

Each superloop supports 120 time slots for voice and data. Eight additional time slots are used to carry out-of-band signaling and messaging information across the fiber-optic link.

Table 1 “Superloop connection configurations” on page 7 list various combination of superloop connections to the Fiber Remote Multi-IPE Interface. The flexibility of superloop use allows for system optimization, which depends on the specific system configuration and traffic requirements.

Maintenance functions

The Fiber Remote Multi-IPE Interface provides a DB-9 female (MAINT) connector at the rear of the unit on the I/O panel. This connector is used as the MMI terminal port at both the local and the remote sites.

This MMI terminal is used to perform the following functions:

- Configuration of the fiber-optic link performance criteria, such as bit error rate threshold
- On-line and off-line diagnostic testing of the fiber-optic link and superloops
- Retrieval of performance statistics such as alarm log, error log, and current performance statistics
- Clear error log files and alarms
- Set time, date, and also sets the name of the site and of the superloop links

The SDI connector, also located on the Fiber Remote Multi-IPE Interface I/O panel, is used to connect the Fiber Remote Multi-IPE Interface to an SDI card in the Meridian 1 system. An MMI terminal at the Meridian 1 local site or at a Remote IPE site can access the system through this SDI port at the Meridian 1 site and perform configuration, maintenance, and test functions of the Meridian 1 system.

A modem port (MODEM) is also provided on the I/O panel. This DB-9 female connector connects a modem to the Fiber Remote Multi-IPE Interface. The modem is used to connect an MMI terminal, which may be located at a maintenance center. This maintenance center may be located in a different city, but by using a modem and public or private telephone facilities, it is able to access the Fiber Remote Multi-IPE Interface equipment at the local and the remote sites. It can also access the Meridian 1 SDI port for Meridian 1 system maintenance. This access is allowed only to the system TTY and the MMI terminals directly connected to the Fiber Remote Multi-IPE Interface MAINT port.

A Fiber Remote Multi-IPE Interface in a multiple unit configuration, can be accessed by logging in on an MMI terminal. An MMI terminal can then access Meridian 1 for system maintenance or a Fiber Remote Multi-IPE Interface at the local or remote sites for maintenance and diagnostic testing and reporting. Only one Fiber Remote Multi-IPE Interface can be accessed at a time. To access an other Fiber Remote Multi-IPE Interface, the current session has to be terminated and a different Fiber Remote Multi-IPE Interface unit can then be accessed by logging in again.

The Fiber Remote Multi-IPE Interface supports the maintenance port transmission speed of 2400 baud.

If multiple Fiber Remote Multi-IPE Interface units are co-located at a site, usually at the local Meridian 1 site, you can daisy-chain Fiber Remote Multi-IPE Interface units to allow a single MMI terminal to access any Fiber Remote Multi-IPE Interface unit in the chain. This is accomplished by daisy-chaining the MAINT and the SDI ports on each Fiber Remote Multi-IPE Interface unit.

The SDI port of the first Fiber Remote Multi-IPE Interface in the daisy-chain can be optionally connected to an SDI port on the SDI card in Meridian 1. The MAINT port in the last Fiber Remote Multi-IPE Interface in the daisy-chain is connected to the MMI terminal.

Fiber Remote Multi-IPE Interface units in a daisy-chain have unique addresses, which are set by a dip-switch setting on the motherboard. This allows you to select a specific Fiber Remote Multi-IPE Interface in the chain when you log in on the MMI terminal to perform configuration, maintenance, or testing of that Fiber Remote Multi-IPE Interface unit.

System monitor interface

The system monitor card resides in the Meridian 1 and Remote IPE pedestals. It monitors the power and the temperature in all modules in the Meridian 1 column and in the Remote IPE column. The master system monitor is located in the Meridian 1 common equipment pedestal. It receives the information from modules in its own column, from the slaves system monitors located in other co-located columns, and from each Remote IPE system monitor over the fiber-optic link.

The Fiber Remote Multi-IPE Interface I/O panel provides two 6-pin modular jacks, which are used to connect the system monitor to the Fiber Remote Multi-IPE Interface for transmission of power and temperature status from the Remote IPE to the Meridian 1 over the fiber-optic link.

If multiple Fiber Remote Multi-IPE Interface units are co-located at the local site, these units are daisy-chained by connecting the XSM OUT modular jack of one Fiber Remote Multi-IPE Interface unit to the XSM IN modular jack of the other unit in the chain. Only one Fiber Remote Multi-IPE Interface unit 6-pin XSM IN (J5) modular jack is connected to the J6 of the master system monitor or a slave system monitor that is hierarchically higher than the highest Fiber Remote Multi-IPE Interface unit connected to it.

At the Remote IPE site, the system monitor J5 modular jack is connected to the J5 XSM IN modular jack of the corresponding Fiber Remote Multi-IPE Interface unit. The information from the system monitor is transmitted over the fiber-optic link to the local site Fiber Remote Multi-IPE Interface unit. If multiple Fiber Remote Multi-IPE Interface units are co-located at the local site, they are daisy-chained and only one Fiber Remote Multi-IPE Interface unit is connected to the local master system monitor or to a slave system monitor hierarchically higher than the highest Fiber Remote Multi-IPE Interface unit.

Diagnostic functions

The Fiber Remote Multi-IPE Interface provides diagnostic functions to monitor the equipment performance and to automatically issue an alarm that corresponds to the type of fault detected. The alarm may be issued in the form of an lit LED, a message displayed on the MMI terminal or system maintenance terminal, a printed error report, or a combination of these fault indicators.

The Fiber Remote Multi-IPE Interface system diagnostics consist of:

- Background diagnostics
- On-line diagnostics
- Off-line diagnostics

Background diagnostic routine continuously monitors the fiber-optic link and the superloop timeslots for error conditions, loss of clock, loss of signal, and loss of frame.

When the fiber-optic link fails or the superloop shows an error condition, a normally open alarm relay contact will close activating an alarm, an LED is lit at each end of the fiber-optic link, an error report is displayed on the maintenance terminal at each end of the link, and an entry is made in the Fiber Remote Multi-IPE Interface system alarm log indicating time, date, location, and type of alarm. A RED ALARM indicates that an error was detected at this side of the fiber-optic link and a YELLOW ALARM indicates that the error condition was detected at the opposite side of the fiber-optic link.

The Fiber Remote Multi-IPE Interface can be configured to automatically clear the alarm condition when the problem clears, or it can be configured to continue to indicate the alarm condition until is cleared by a command over the MMI terminal or by pressing the ALM CLEAR button on the Fiber Remote Multi-IPE Interface unit faceplate at the local or the remote site.

On-line diagnostics does not interfere with the normal system operation and is performed on an active link.

Off-line diagnostics may interfere with the normal system operation and is performed on an idle or faulty fiber-optic link or a disabled superloop. To minimize the impact of off-line testing, a superloop should first be software disabled and then tested while the other superloops are carrying traffic.

The off-line diagnostic testing can perform loopback tests of the superloop data, clock and frame signals, and on the fiber-optic link.

Commands can be issued over the MMI terminal to specify the superloop that should be tested and the duration of the test. Multiple superloops can be simultaneously tested, if so desired.

To perform loopback testing of the fiber-optic link, an attenuated loopback fiber-optic cable must be used at the end of the link that is being looped back. This test is used to verify the performance of the fiber-optic link and the Fiber Remote Multi-IPE Interface unit fiber-optic interface circuits.

Card-LAN interface

The Card-LAN is a 19.2 kbps asynchronous interface. It is used to poll peripheral equipment lines and communicate over the fiber-optic link to transmit maintenance messages between the Superloop Network card and the Peripheral Controller. These messages include:

- LED control of the IPE card enable/disable
- peripheral card configuration
- peripheral card type and version information

Alarms and LED indicators

The Fiber Remote Multi-IPE Interface provides LED indicators and external alarm connections to enable error detecting and external alarm reporting.

External alarm indicators. The Fiber Remote Multi-IPE Interface unit I/O panel contains the DB-9 female ALM connector to connect the external alarms to the Fiber Remote Multi-IPE Interface unit.

The connector provides:

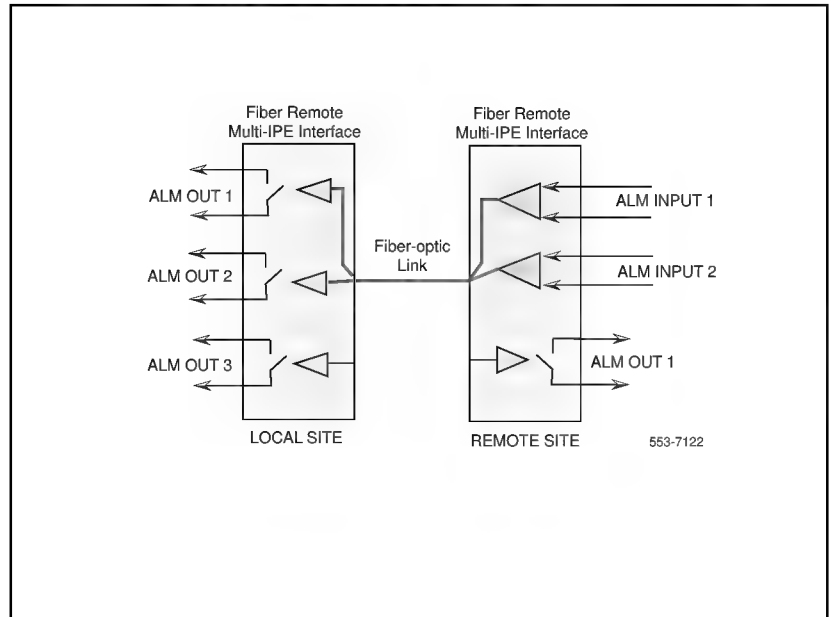
- Three external alarm outputs on each local Fiber Remote Multi-IPE Interface unit
- Two external alarm inputs and one external alarm output on each remote Fiber Remote Multi-IPE Interface unit

The two external alarm inputs (alarm input #1 and #2), when activated, are transmitted from a remote Fiber Remote Multi-IPE Interface over the fiber-optic link to the local Fiber Remote Multi-IPE Interface to activate two out of three external alarm outputs (alarm outputs #1 and #2) on the local Fiber Remote Multi-IPE Interface unit. At the local site the alarm output #3 is activated when the fiber-optic link detects an alarm condition.

The single alarm output at the remote Fiber Remote Multi-IPE Interface will be activated if an external alarm is activated or if the fiber-optic link detects an alarm condition.

Figure 5 illustrates the external alarm inputs at the remote Fiber Remote Multi-IPE Interface location and the corresponding alarm outputs at the local Fiber Remote Multi-IPE Interface connected to Meridian 1.

Figure 5
External alarm inputs and outputs



LED indicators. The LED indicators are located on the faceplate of each Fiber Remote Multi-IPE Interface unit. These LEDs are:

- Power LED. Indicates that the Fiber Remote Multi-IPE Interface passed self-test and the AC/DC power converter powering the Fiber Remote Multi-IPE Interface is operating correctly.
- Red Alarm LED. Indicates a near end fault condition. This near-end fault condition activates the Yellow Alarm LED at the far-end Fiber Remote Multi-IPE Interface.

- Yellow Alarm LED. Indicates a far-end alarm condition. This alarm LED is activated by a far-end fault condition (when the Red Alarm LED is activated at the far-end).
- Maintenance In Progress LED. Indicates that a function in the fiber-optic link or one or more superloops have been disabled using maintenance commands. The LED will also be lit if a service-effecting off-line diagnostic test is in progress.

Engineering guidelines

Meridian 1 general system engineering guidelines are described in *Meridian 1 system engineering* (553-3001-151). The following information deals specifically with engineering guidelines for the Fiber Remote Multi-IPE Interface planning and implementation. It also describes the fiber-optic interface specifications and fiber-optic link characteristics.

Remote IPE capacity

Meridian 1 physical capacity depends on the system's configuration and size. System options 21E, 51, 51C, 61, 61C, 71, 81, and 81C are designed to provide port capacities from tens to thousands of ports. These ports are normally local to Meridian 1, however, by implementing Fiber Remote Multi-IPE Interface, many of these ports can be located at one or more remote sites.

The overall maximum system capacity does not change by installing Fiber Remote Multi-IPE Interface units to support distributed peripheral equipment (subscriber loops) at Remote IPE sites. Fiber Remote Multi-IPE Interface allows you to distribute the peripheral equipment at long distances from Meridian 1 and provide the same functions and features to remote subscribers as to local subscribers.

The Fiber Remote IPE capacity can be tailored according to port capacity requirements at the remote site. When planning a Remote IPE site, you must determine the number of IPE cards required to support the existing and future traffic needs and the call blocking tolerance.

A Remote IPE column consists of the Meridian 1 pedestal, from one to four IPE modules, and a top cap. One IPE module supports up to 16 line cards, or 256 ports if each line card has 16 ports (other IPE cards may have a different number of ports). If more ports are required, additional IPE modules can be added to the column. A column contains a maximum of four IPE modules providing a maximum of 1024 subscriber loops. Each IPE module requires one Peripheral Controller card located in the IPE module *Cont* card slot and a corresponding one to four superloops provided in Meridian 1 by the Superloop Network card(s).

Depending on the number of superloops required, the type of optical fiber used in the link, the appropriate Fiber Remote Multi-IPE Interface unit must be selected from Table 2 “Equipment required to link Meridian 1 to Remote IPE sites” on page 8.

The number of superloops required to support a Remote IPE module depends on the traffic requirements. If a non-blocking traffic condition is required, the Remote IPE module requires a minimum of three superloops. Each superloop supports 120 time slots or 7 line cards. To support 16 line cards, three or four superloops should be used. If traffic blocking is not an issue, one superloop will be sufficient to support one Remote IPE module.

Engineering the fiber-optic link

A fiber-optic link can be constructed using single-mode or multi-mode fiber-optic cables. The type of fibers you select will depend on various factors:

- distance between Meridian 1 and the Remote IPE site
- possible existence of a fiber-optic link you wish to use for this application
- cost and availability of fiber-optic cables

Single-mode Fiber Remote Multi-IPE Interface units are compatible with multi-mode fiber-optic link at the appropriately calculated attenuation limits. However, multi-mode Fiber Remote Multi-IPE Interface units are not compatible with the single-mode fiber-optic link.

When engineering a fiber-optic link, you must consult the component manufacturer’s data sheets to determine whether the cable, connectors, and other components meet the transmission characteristics and the signal loss plan for the transmission distance required for your specific Remote IPE application.

Fiber-optic interface specification

When planning a fiber-optic link, you must consider the transmit and receive signal power and the signal attenuation of each component in the link to determine total signal attenuation.

Table 4 shows the transmit and receive signal power level at the signal source and the signal destination. The receive circuit on the electro-optical interface will detect a signal at a level as low as -30 dBm.

Table 4
Fiber-optic transmit and receive signal levels

Signal source	Transmitted power	Received power
	Min	Min
Fiber Remote Multi-IPE Interface	-15 dBm	-30 dBm

Fiber-optic link loss characteristics

The fiber-optic link components add to the total end-to-end link signal attenuation. The fiber-optic cable attenuation depends on the type of cable selected. The manufacturer's data sheet provides parameter values, which must be considered when engineering the link. In addition, the signal attenuation is also affected by the number of splices in the link and the signal loss in the link terminating the fiber-optic connectors.

Table 5 shows an example of different fiber-optic link components and the total signal attenuation for a 10 km link of 10.2 dB for a high quality single-mode fiber.

Table 5
Example of fiber-optic link components and their attenuation factors

Component	Quantity	Attenuation in (dB)	Total attenuation in (dB)
High quality single-mode fiber (10 km)	1	0.5/km	5.0
Medium quality splices	10	0.2/splice	2.0
ST connector pairs	4	0.8/connector pair	3.2
Note: XMIT A and RCV A connector pairs on the faceplate do not count when calculating the attenuation across the link.			

Maximum calculated signal attenuation across the link is 10.2 dB, which allows 4.8 dB safety margin for a single-mode fiber.

Note: Actual attenuation must be determined by measuring the end-to-end signal loss. Because of the 45 Mbps data rate, dispersion loss is not a factor with either single-mode or multi-mode fibers. With good quality cable and splices, the Remote IPE modules can be located up to 15 miles from the network module for single-mode fibers and up to 6 miles for the multi-mode fibers. A safety margin for the attenuation loss is designed into the Fiber Remote Multi-IPE Interface unit over the specified usable power budget.

Fiber-optic cable types

If a fiber-optic link already exists, it must be evaluated to determine if it will support the Fiber Remote Multi-IPE Interface and, if it will, at what distance from Meridian 1. The distance of the link can be determined by finding a point of the fiber-optic link where the signal loss is less than 15 dB for a given transmission rate over a single-mode fiber and less than 10 dB for the multi-mode fiber.

To evaluate an existing link, measure the end-to-end attenuation to determine the link's suitability for the Fiber Remote Multi-IPE Interface application.

A fiber-optic link may be composed of single-mode or multi-mode fibers, splices, and fiber-optic connectors. ST-type fiber-optic connectors have to be installed onto fibers of the fiber-optic link cables so that the link can be directly connected to the ST-type fiber-optic connectors on the Fiber Remote Multi-IPE Interface unit faceplate.

Fiber-optic link calculation examples

The following fiber-optic link calculations for both single-mode and multi-mode fibers illustrates how to evaluate the distance of a link based on the type of fiber and attenuation of the fiber and splices.

Example 1 - Medium quality multi-mode fiber-optic cable and splices

Medium quality multi-mode fiber-optic cable has a loss of 1.5 dB per km. Medium quality splices have 0.5 dB loss per splice.

Assumptions:

- dB loss allowed over multi-mode fiber by the Fiber Remote Multi-IPE Interface: 10 dB
- dB loss per km of fiber: 1.5 dB
- dB loss per splice: 0.5 dB

Assume a 5 km length of fiber link made from five 1 km lengths of fiber-optic cable with four splices in the cable (one splice every 1 km).

Calculations:

$$\text{dB loss} = (5\text{km}) \times (1.5 \text{ dB per km}) + (4 \text{ splices}) \times (0.5 \text{ dB per splice})$$

$$\text{dB loss} = 7.5 \text{ dB} + 2.0 \text{ dB} = 9.5 \text{ dB}$$

$$\text{Safety margin} = 10 \text{ dB} - 9.5 \text{ dB} = 0.5 \text{ dB}$$

Example 2 - High quality multi-mode fiber-optic cable and splices

High quality multi-mode fiber-optic cable provides a loss of 1.0 dB per km. High quality splices provide 0.1 dB loss per splice.

Assumptions:

- dB loss allowed over multi-mode fiber by the Fiber Remote Multi-IPE Interface: 10 dB
- dB loss per km of fiber: 1.0 dB
- dB loss per splice: 0.1 dB

Assume a 9 km length of fiber made from nine 1 km lengths of cable with eight splices in the cable (one splice every 1 km).

Calculations:

$$\text{dB loss} = (9\text{km}) \times (1.0 \text{ dB per km}) + (8 \text{ splices}) \times (0.1 \text{ dB per splice})$$

$$\text{dB loss} = 9.0\text{dB} + 0.8 \text{ dB} = 9.8 \text{ dB}$$

$$\text{Safety margin} = 10 \text{ dB} - 9.8 \text{ dB} = 0.2 \text{ dB}$$

Example 3 - Medium quality single-mode cable and splices

Medium quality single-mode cable provides a loss of 1.0 dB per km. Medium quality splices provide 0.2 dB loss per splice.

Assumptions:

- dB loss allowed over single-mode fiber by the Fiber Remote Multi-IPE Interface: 15 dB
- dB loss per km of fiber: 1.0 dB
- dB loss per splice: 0.2 dB

Assume a 12 km length of fiber made from twelve 1 km lengths of cable with eleven splices in the cable (one splice every 1 km).

Calculations:

$$\text{dB loss} = (12\text{km}) \times (1.0 \text{ dB per km}) + (11 \text{ splices}) \times (0.2 \text{ dB per splice})$$

$$\text{dB loss} = 12.0\text{dB} + 2.2 \text{ dB} = 14.2 \text{ dB}$$

$$\text{Safety margin} = 15 \text{ dB} - 14.2 \text{ dB} = 0.8 \text{ dB}$$

Example 4 - High quality single-mode cable and splices

High quality single-mode cable provides a loss of 0.5 dB per km. High quality splices provide 0.1 dB loss per splice.

Assumptions:

- dB loss allowed over single-mode fiber by the Fiber Remote Multi-IPE Interface: 15 dB
- dB loss per km of fiber: 0.5 dB
- dB loss per splice: 0.1 dB

Assume a 25 km length of fiber made from twenty-five 1 km lengths of cable with twenty-four splices in the cable (one splice every 1 km).

Calculations:

$$\text{dB loss} = (25\text{km}) \times (0.5 \text{ dB per km}) + (24 \text{ splices}) \times (0.1 \text{ dB per splice})$$

$$\text{dB loss} = 12.5\text{dB} + 2.4 \text{ dB} = 14.9 \text{ dB}$$

$$\text{Safety margin} = 15 \text{ dB} - 14.9 \text{ dB} = 0.1 \text{ dB}$$

System selection

In some applications where non-blocking or low blocking traffic considerations are important, you have to limit the number of peripheral cards supported by each superloop. For a non-blocking condition, the 120 voice/data time slots (one superloop) will support seven or eight 16-port line cards. Each additional line card in the IPE module increases call blocking under high traffic conditions. Refer to *Meridian 1 system engineering* (553-3001-151) to calculate traffic.

A Remote IPE module supports 16 line cards and provides a maximum of 256 ports (different IPE cards provide different number of ports). This column may be expanded by adding more IPE modules to support an additional ports. Each IPE module requires a Peripheral Controller card at the remote site and a corresponding one to four Superloop Network cards at the local Meridian 1 site.

In addition to line cards, the Remote IPE supports all the cards that do not require external connection to Meridian 1 common or network equipment.

Remote IPE site planning

When you select a site for your Remote IPE, you must consider the number of ports currently required at the site and the possibility of expansion to meet future needs. You also must consider environmental, power, and cable routing requirements.

Environmental requirements

The Fiber Remote Multi-IPE Interface conforms to the same environmental requirements as the rest of the Meridian 1 equipment. Temperature, humidity, and altitude for Meridian 1 equipment operation should not exceed the specifications shown in Table 6.

Table 6 shows the operating and storage environmental specifications. Ideally Meridian 1 equipment should operate in a stable environment at 22° C (72° F); however, the system is designed to operate in the temperature and humidity ranges specified in the table.

Table 6
Environmental requirements

Condition	Environmental specifications
Operating	
Temperature	0° to 50° C (32° to 122° F)
Relative humidity	5% to 95% noncondensing
Altitude	3,048 meters (10,000 feet) max
Storage	
Temperature	–50° to 70° C (–58° to 158° F)
Relative humidity	5% to 95% noncondensing

Power requirements

Power for the Remote IPE modules is provided by the power converter in each module.

The Fiber Remote Multi-IPE Interface requires -48 V DC at 0.6 Amps. An AC/DC power converter is optionally shipped with each Fiber Remote Multi-IPE Interface unit to provide the required power for the Fiber Remote Multi-IPE Interface unit. This power converter is wall-mounted next to the Fiber Remote Multi-IPE Interface unit.

A DC power source for the Fiber Remote Multi-IPE Interface unit is a -48 V also used by the Meridian 1 system or the Remote IPE column. This source is usually available if the system is DC-powered or has a DC backup power source.